VIDEO PERCEPTION INCORPORATED

(Preliminary)

MT100 Multi-Tracker Unit
(Video Motion detection of Multiplexed Channels)

HARDWARE FEATURES

- Provides Economical Processing Speed
- Provides Improved Quality of Motion Detection to Reduce False Alarms
- Permits size Discrimination
- Operates using Economical Power-Line Sync Video Cameras
- Operates Single Channel or Multiplexed (4 or 8)
- Does not Require all (4 or 8) Channels Connected for Multiplexing
- Has MicroController Interface to Computer Communications
- Provides Discriminating Image Processing Motion Detection
  (see data sheet for IPP3000R)
- Filters Image Noise
- Provides Automatic Lighting Compensation (ALC) for up to 8-Channel Concurrent Operation
  (image gain-processing range of -7.5 to +40 db)
- Processes 640 x 240 Pixel/Field Image
- Performs Periodic Self-Test - Defies Intruder Disablement
- Develops Motion Tracking Data - All Channels
- Enables Object Profile ID
- Supports High Resolution Masking
- Provides Encoded Digital Output (Serial) to Receiver
  - All Operating Channel Alarm Status
  - All Operating Channel Self-Test Status
  - All Operating Channel Tracking Data
  - Multiplexed Channel ID and Odd/Even Field Status
  - Scan Line and Field Synchronization
- Enables Inexpensive Data Recovery at Receiver - System Costs are Reduced
- Supports **Autonomous** System Design

SOFTWARE FEATURES

- Operates with Visual Basic Program
- Links to User Defined Software
- Provides Setup Entry for all Controllable Features of all Channels
  - Threshold Processing
  - Tolerance of Intrusion
  - NTSC/PAL Operation
  - Mask Data Transfer from Computer
  - Single/4/8 Channel Operation
  - Single Channel Operation (1 of 8)
  - Mask On/Off
  - Edge/Change Contrast Detection Mode
  - Track/Mask Display Selection
  - Mask Load Control
- Provides Visual Mask Entry for all Channels
  (supports overlay of mask to digitized image)
- Controls Transfer of Mask Data to Hardware
- Communicates with Hardware for Data Transfer Confirmation
- Supports Expansion to Multiple MT100 Unit Control
- Detects and Reports Alarm and Self-Test Status
- Detects and Reports ALC, Threshold and Tolerance Response

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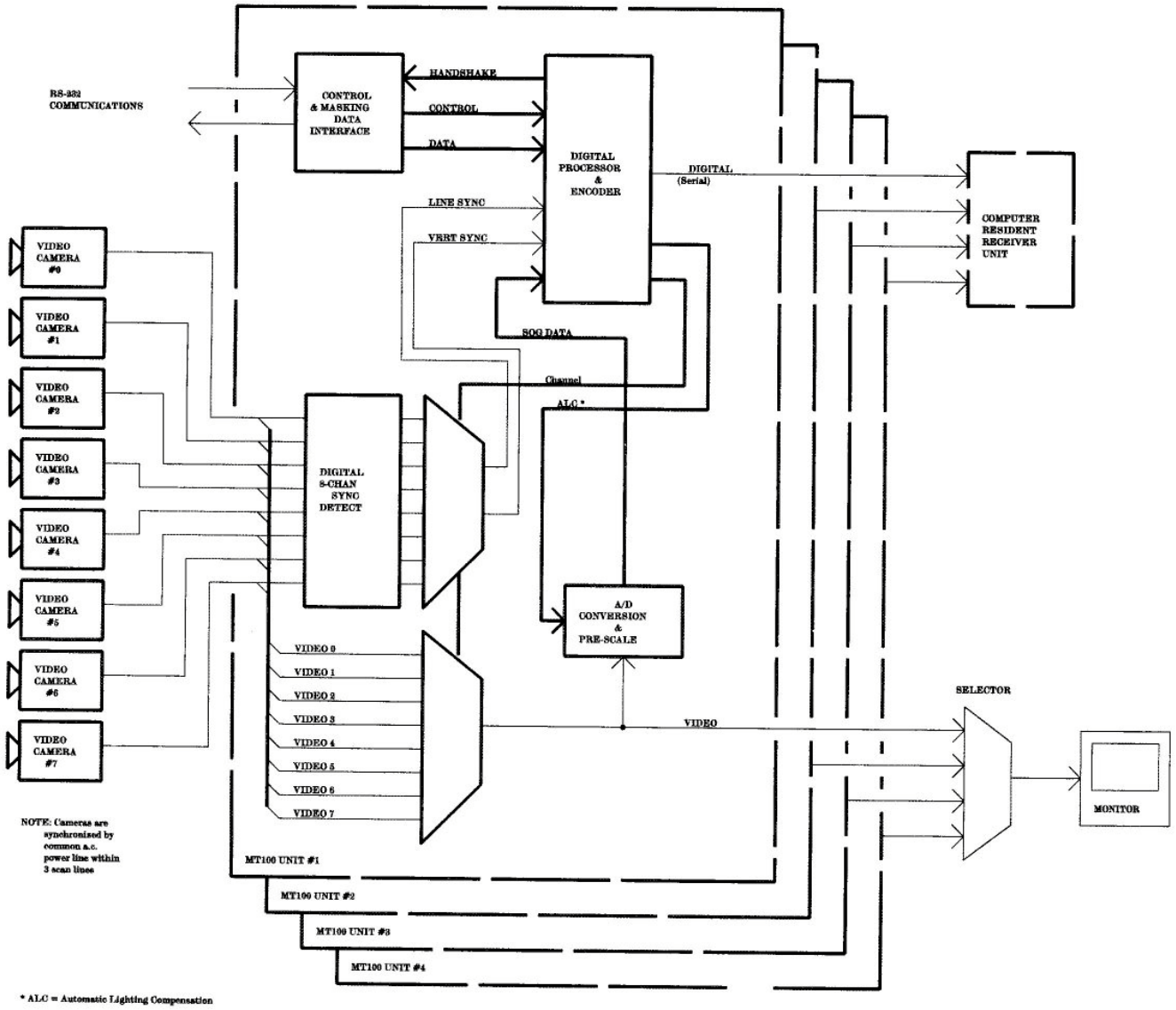
BLOCK DIAGRAM OF MT100 UNIT IN AN OPERATING SYSTEM



GENERAL DESCRIPTION

The Video Perception Inc. Multi-Tracker (MT100) Unit provides up to eight-channel video multiplexed operation with the incorporation of high-performance video motion detection. See the Block Diagram of the MT100 Unit in an Operating System. It performs most of the functions of a Sequencer or a Multiplexer with significant additional capabilities. It differs substantially from the industry classification of video multiplexers. The unit provides an analog video output and a high-speed serial digital output. The digital output transmits multiplexed alarm status, self-test status, odd/even field status, motion tracking data and video sync timing for each channel. It also includes the current multiplexed channel selection. The video cameras of the system can be of the inexpensive power line synchronizing type of NTSC or PAL format. These cameras may operate over a wide variation of lighting conditions; the MT100 Unit compensates this range (of each channel). This unit is controlled from a serial RS-232 port of a computer to provide many dynamic control options. These controls permit the discriminating of intruders by size allowing a pet to be undetected while detecting a person. The unit provides a means of loading a high-resolution mask configuration for each channel; motion is not detected in the masked regions.

OPERATING DESCRIPTION

The video motion detector of the unit uses a patented principle of locating edges in both the horizontal and vertical directions (U.S. Patent # 4,897,719). The edges are uniquely processed to provide substantially improved results that minimize false alarm conditions, while maximizing system sensitivity to insure positive detection. The image viewing area is subdivided into very small units (cells). This viewing area/field is made up of 9600 cells (160 x 60). The horizontal and vertical edge processed results are encoded into a single bit representing the boundary status of a cell. This approach provides a greatly reduced volume of data (128 times reduction when compared to 8-bit digitized video data) which represents the status of many pieces of the image. This condensed data format provides faster processing speed, as well as a significant reduction of support electronics. A Reference image, in this condensed format, is stored in RAM at timed intervals or when directed by a remote computer. While operating in the multiplexed mode at NTSC field rates, the currently processed image is compared to the corresponding channel Reference image at 6.67 samples-per-second rate for 8-channel operation and at 12 samples-per-second for 4-channel operation. If the degree of motion exceeds the computer-selected amount, an alarm will be set for each channel in alarm status. Additional information about the processing algorithm is provided in the data sheet for the IPP3000R (CMOS Real Time Image Pre-Processor).

The unit is designed to be a satellite box of a security system; multiple units at zones of coverage could be deployed in large systems. The unit will service a cluster of up to eight video cameras. It provides "front-end" video motion detection. It processes the sync signals from all of the video cameras to maintain synchronization with each of the channels. The unit generates motion detection and sync timing data; it transmits these data over a digital line to the receiving station. The receiving station can utilize this timing to interpret the x-y axis location of the motion data without repeating the processing. Video Perception Inc. offers an integrated circuit that processes this digital channel. It decodes the timing, the alarm status, the self-test status, the odd/even field status, and the tracking data for each channel. Enough data are transmitted to computer-process the tracking data to identify the intruder profile and to track selected intruder profiles. It will permit pan and tilt control of the video cameras for tracking control. The reduced volume, of these real-time data, makes it attractive for software processing to form autonomous threat discussions. The MT100 Unit is a **key building block** of simple to very sophisticated security systems.

PHYSICAL DESCRIPTION

The physical enclosure of the MT100 Unit is 8" x 6 1/2" x 2 3/4". There are eight BNC connectors for input channels and one BNC connector for the analog video output signal. There is a twin-axial connector for the digital output. There is a power-input connector for a wall transformer (power supply), a power switch, and a power indicator. There is a 9 pin D-Sub connector for the serial port connection to a computer. A view of the unit is shown on the front page.

The MT100 Unit can be competitively priced due to its relatively simple construction. Since it also contributes to the simplification of construction of the receiving equipment and architecture of interconnect cabling, it offers system economy.

CORRELATOR FUNCTION

The MT100 Unit must encode the multiplexed outputs previously described to a single serial digital output in a format that can be decoded at the receiving end of the system (using another unit). The synchronous timing (both line sync and vertical sync) are detected, using hardware, for each of the channels. These sync signals are encoded using a correlation pattern that can be uniquely recognized at the receiving end. The timing delay, for recognition, is compensated (at the receiving end). This accurately identifies the timing of the sync events. Special data are transmitted during a single scan line within the vertical blanking interval. The special data include alarm status, self-test status, odd/even field status, and the channel multiplexed selection of the current field. A unique correlation pattern precedes these special data for identification and timing. The remainder of the field transmission consists of tracking data with encoded line sync correlation patterns on each scan line for timing synchronization. The companion Video Perception decoding integrated circuit will reproduce all of the data and will control the x-y address of the tracking data for RAM storage.

The data are transmitted at a 3 mega-hertz data rate over a single transmission line.

INTERLACED DATA HANDLING

The MT100 Unit processes data on a per field basis. It provides for the reception of both odd and even field data; these are alternately transmitted for each channel (while operating in the multiplexed mode). The multiplexer provides for a sequencing of the channels selected; there is an even number of fields (either 4 or 8). Channel 1 is transmitted twice to cause an odd number of fields sent each cycle; this causes alternate odd/even field selection for each of the channels.

POWER LINE SYNCHRONIZATION

The MT100 Unit is designed to accept up to eight video camera inputs. The synchronization of these camera inputs must be within three horizontal scan lines; for NTSC operation, this tolerance is approximately 190 milliseconds. This generous tolerance for synchronization permits use of video cameras of the power-line sync type.
The cameras may be either of the color or mono-chrome type; the color (if any) will be maintained through the video routing to the receive end for viewing. The internal processing is done in mono-chrome.

COMMUNICATIONS

The MT100 Unit communicates with a system computer at the unit input though an RS-232 link operating at 9600 baud. This link permits operational set-up control of the unit and allows transfer of masking data to the unit. It also permits command confirmation and data transfer verification to the computer. The MT100 Unit has two outputs. One is a multiplexed video output and the other is a serial digital output. These outputs are to be used at a receiving location from the respective two transmission lines. The same system computer (or another computer) could process the digital output through an interface board. The video output can be used for visual observation.

SET-UP CONTROL AND MONITORING

There are provisions for the system computer to select all of the operating conditions of the MT100 Unit. The unit provides handshake for verification of the selection options. The options independently selectable for each channel are threshold and tolerance values (see data sheet for the IPP3000R). The mask On/Off selection for each channel is also independently selectable. There are seven threshold and 16 tolerance selections. A command to load a channel mask is also selectable to each channel. Selections applicable to all channels (not individually selectable) of the unit are Single/4-channel/8-channel operation, Edge/Change Contrast Detection Mode, and Track/Mask Display.

The system computer can monitor the operational status of the MT100 Unit. It can monitor the alarm and self-test status of each channel. These are displayed on the computer monitor as if they were indicator lights (red for alarm or fail, green for no-alarm or pass). It displays the monitored threshold, ALC gain (db), mask On/Off status, track/mask status, single/multiplexed status, channel selection, alarm status, Odd/Even Field status, and test interval status for the selected channel during single channel operation. Much of this is for diagnostics operation.

MASKING

Masking provides the operator the ability to ignore motion in selected areas of the processed image on a per-cell basis. The operator views a digitized image from a video camera of the security system. He selects one or more contiguous areas of exclusion from the 640 x 480 pixel viewed image. There are 9600 cells/field for the viewed image. The operator may instead elect to select areas of motion detection inclusion (all other areas being excluded) by this means. Areas of selection are developed through mouse entry of rectangles. Many rectangles of various sizes and overlapping positions may be entered to form the selection. Once the selection is made, a disk file is generated to save this selection. The operator may do this for each of the camera locations. Multiple selection may be made for the same camera; the file names will identify the selection. The selection may later be viewed at the output of the MT100 Unit for selection and operational verification (discussed later).

Once mask files have been developed for each camera, the operating program permits the selection and transfer of this mask data to the MT100 Unit. These data are stored in RAM of the MT100 Unit for all applicable channels. The unit is then ready for operation with mask exclusion for all operating channels.

STATUS REPORTING

There is status reporting to both the system computer and also to the output receiving location. Some of the status reporting is redundant but sent to the two locations.

1) **Reporting to the System Computer -** Much of the reporting to the system computer has previously been discussed. An alarm report is a result of exceeding the motion detection tolerance levels at the selected threshold level. The self-test report is made at intervals selectable by the computer; it reports pass/fail status of the monitored channel.
2) **Reporting to the Receiver Location** - The alarm and self-test status is reported each field for the selected channel. In multiplexed operation, the selected channel is changing at the field rate (60/sec for NTSC operation). The self-test status changes at a rate selectable by the system computer (same as the Reference Image update rate). The channel selection and odd/even field status are reported each field. Tracking data are the cell motion status indications (1-bit/cell) that are scanned to the output in the same pattern as the video display to the monitor. These are reported with timing provisions encoded to recover these data. There are provisions at the system computer to select either this tracking data or the mask data for the selected channel

. The mask data can be recovered and displayed at the receiver location for verification of the mask set-up.

PROCESSING

The MT100 Unit utilizes a customized integrated circuit for its processor that incorporates the features of the IPP3000R integrated circuit; these are defined in the data sheet for the IPP3000R. These features will not be repeated; only unique processing will be discussed.

1) **Field Size** - The MT100 Unit operates at a pixel sample rate of 12.6 MHz. During NTSC operation, this creates a digitized image of approximately 640 x 480 pixels per frame image. The unit processes on a per field basis; consequently, the image field size is 640 x 240 pixels.
2) **NTSC/PAL Operation** - The processing integrated circuit provides for NTSC or PAL operation; however, the MT100 Unit operates only in the NTSC mode.
3) **Automatic Lighting Compensation (ALC)** - The MT100 Unit has the capability to sense the average image lighting level for each channel. It provides feedback control to a digital prescaler device to adjust the gain of the digitized video input. This control maintains the average digitized image intensity being processed to approximately constant over a wide range of ambient lighting. A separate feedback control is provided for each channel. The image processing used for motion detection is capable of quality operation over large lighting ranges with independent control for each channel of multiplexed operation. The control has hysteresis to permit stable operation over the lighting range.
4) **Multiplexer Options** - There are three channel sequencing selections available. Single channel operation permits a selected channel (1 of 8) to be operated steady state. Selection of 4-channel operation causes the multiplexing of channels 1 through 4 in the order of normal count progression. Selection 8-channel operation causes the multiplexing of channels 1 through 8 in the order of normal count progression.
5) **Edge/Change Mode Selection** - The edge mode provides the better results of the two operating modes. An image noise suppression algorithm is applied to this mode. The algorithm does not work for the change mode; consequently, the change mode has some background noise in the tracking data. The change mode does offer a unique capability to capture and hold an intrusion profile.
6) **Self-Test** - The self-test is for each channel in operation. The operator selects a reference RAM update rate from several options; the smallest interval is every one-second. The self-test detects the object edge background information instead of the number of edges in motion. Since these are much more plentiful, the pass condition is a detection of alarm overflow count of the motion detector. If an intruder attempted to cover the camera lens, he would cause the self-test to fail; equipment failure would also cause this failure. If the cabling were to be cut by an intruder, a second or'ed condition would detect this and report a failure.

APPLICATIONS

1) **Expandable Security Systems** - Each MT100 Unit in a system will support up to eight video channels and will provide one serial output to transmit these channels concurrently. Therefore, a 32-camera system would require four MT100 Units with four digital transmission lines routed to a receive location.

2) **Receiver Projections** - The ideal receiver would be a PCI bus circuit board installed in a receive-computer (could be the system computer). It would accommodate the four transmission line inputs; it would decode (with the VPI decoder chip) the data transmission and pass these data (16 or 32 bits wide) via the bus to the computer memory. The computer should be able to process 32 channels concurrently.
3) **Autonomous Operation** - The computer could monitor the alarm status flags for detected motion. When motion is detected, it could analyze the tracking data for object ID and motion vectors. It could adjust the applicable camera's pan and tilt control to track the object. It could then report threat results by one of many possible means (sound, lights, modem to remote location, etc).

The primary goal of this system is to communicate data used to evaluate motion threat to a computer (not to a human); it displays or can be used to record video data as a secondary function. **The system is intended to be autonomous.**

APPLICATIONS

- Multi-Channel and Multi-Zone Video Security Systems
- Self-Tracking Systems with Pan-Tilt Control
- Visual Spectrum and Infra-Red Applications
- Autonomous Threat Evaluation and Intrusion ID
- Large Network Applications with Multiple MT100 Units
- Border Patrol
- Military Security